REMARKS

In response to the restriction requirement, Applicants affirm the election to prosecute claims 2-22 drawn to a printed wiring board. Applicants further reserve the right to file one or more divisional applications to continue the prosecution of claim 1.

The Examiner has requested that a drawing be furnished to facilitate understanding of the invention. Accordingly, a proposed FIGURE 1 is submitted with this Amendment for the Examiner's consideration. It is believed that the features shown in the drawing are fully supported by the specification, and that no new matter has been introduced. In addition, the specification has been amended to refer to the proposed drawing, as well as the features illustrated in the drawing. The language added to new paragraph 84 may be found at paragraphs 13 and 14 of the specification. Thus, no new matter has been added to the specification.

Claims 2-22 stand rejected under 35 U.S.C. §103 (a) as being unpatentable over Minten, U.S. Patent No. 4,684,560. With regard to claim 2, it is the Examiner's position that Minten discloses all of the features of the presently claimed pringed wiring board, except that Minten does not explicitly disclose carbon having a mean particle size not greater than about 1 micron. With respect to independent claim 20, it is the Examiner's position that Minten discloses applying a graphite coating as claimed. The dependent claims 3-19 and 21-22, including dependent claims 3-11, claiming various resistivities between the conductive circuit layers, and claim 18, claiming specific organic binding agents, are rejected as claiming obvious properties or selection of materials for the printed wiring board. As set forth more fully below, the Examiner's positions are respectfully traversed.

BACKGROUND

Before the present invention was made, aqueous conductive at col. 4, lines 4-16, through hole coating compositions containing nonmetallic, electrically conductive particles were developed to avoid the expense and disposal problems associated with direct deposition of metal on a nonconductive surface or the use of nonaqueous solvents. A prior art conductive coating process employing an aqueous dispersion of carbon black is commercially available under the BLACKHOLE trademark. It is difficult to make the BLACKHOLE process work, however, and it provides a coating with an undesirably high electrical resistance. The disadvantages of employing a coating having a high electrical resistance are described in Applicants' U.S. Patent No. 5,725,807, at col. 4, lines 4-16, which patent has been expressly incorporated by reference in the present specification, at paragraph 1. The BLACKHOLE process is essentially the same process disclosed in the Minten reference cited by the Examiner and discussed further below.

The electrical resistivity problem with the carbon black process has been addressed commercially in the BLACKHOLE process by depositing a second coat of carbon black over the first to lower the resistivity of the coating. This two-pass process requires more materials, time, and equipment than a one-pass process.

The initially nonconductive through holes or other recesses of the printed wiring boards according to the present invention are made electrically conductive by providing a single-pass coating containing, in addition to graphite and/or carbon black, an organic, water-dispersible binding agent. The coating can be formulated and applied to be very thin and to have much lower resistivity than prior water-based carbon black compositions. The organic, water-dispersible binders used in the coating formulation allow the carbon coating to adhere far better than before when the board is

subjected to electroplating and the thermal and mechanical stress of soldering. The present carbon coating accepts electroplating without voids.

To see the radical improvement in resistivity of printed wiring boards in accordance with the present invention compared with boards made with the prior art carbon black BLACKHOLE process one can refer to Example 7 of Applicants' U.S. Patent 5,725,807. In printed wiring board coupons made using the commercial BLACKHOLE carbon black process in a single pass (reported at col. 25, lines 15-25 of the '807 patent), the resistivities were at a minimum of 1200 ohms. For coupons prepared with a preferred graphite/water-dispersible organic binder coating of the present invention, with a single pass, the resistivities were no higher than 172 ohms and as low as 32 ohms. See, col. 26, line 54 – col. 27, line 25. Coupons prepared with a double pass of the graphite/water-dispersible organic binder coating had even lower resistivities.

Turning now to the Minten reference which forms the basis for the Examiner's rejection, Minten discloses applying a carbon black dispersion to the through-holes of a printed wiring board to form a conductive layer in the through holes. Minten teaches that there are three critical ingredients for his carbon black dispersion: 1) carbon black, (2) water or other liquid dispersing medium, and (3) a surfactant. See col. 6, lines 44-48. At no place does Minten teach or suggest a water-dispersible organic binding agent as a dispersion ingredient, as required by all of the present claims. The surfactant functions in the Minten dispersion to disperse the carbon black in the liquid dispersing medium. Col. 8, lines 12-16. The surfactant is also intended to enhance the wetting ability and stability of the carbon black and permit maximum penetration by the carbon black into the through-holes. *See*, col. 8, lines 16-21.

As detailed in the present specification, at paragraphs 36-46, a dispersing agent and/or surfactant is a separate and distinct coating component from the water-dispersible organic binding

agent, and the components have different functions. The binding agent functions to bind the carbon particles to the substrate, whereas the surfactant functions, as similarly taught by Minten, to enhance wetting to permit penetration of the carbon into the recesses of the substrate. Thus, it may be seen that the claimed water-dispersible organic binding agent is a separate component from the surfactant component. Moreover, Minten only discloses a surfactant, and does not teach or suggest that a binding agent should or could be added to the dispersion or that any benefit could be gained by adding a binding agent.

Although Minten teaches that additional ingredients, such as alkaline hydroxide, fumed silica or mineral acid can be added, these components are not organic binding agents. Because there is no teaching or suggestion in the Minten reference of including an organic binding agent in Minten's carbon black dispersion, Minten provides no teaching or suggestion of an electrically conductive coating including a water-dispersible organic binding agent on the nonconductive surface, as required by all of the claims. Absent such a teaching, the present claims cannot be obvious.

Moreover, Applicants' concept of employing an organic binding agent in the carbon dispension to bind the carbon particles to the nonconductive surface is not taught in Minten, or any other prior art relating to carbon dispersions for printed wiring boards. Thus, it was not known in the art, until Applicants' invention, that an organic binder would or could be suitable for use in a carbon dispersion for printed wiring board applications. Therefore, Applicants' preferred binding agents, as claimed in claim 18 cannot be considered an obvious design choice, as argued by the Examiner, because the entire concept of utilizing any water-dispersible organic binding agent, let alone Applicants' preferred binding agents, was not known or recognized by those

skilled in the art. Accordingly, the subject matter claimed in claim 18 is not merely an obvious choice of design.

The Examiner asserts that it would have been obvious from the teachings of Minten to employ graphite as the carbon material, as claimed in claim 19, and that the printed wiring board of claim 20, employing a graphite coating, would likewise have been obvious. The Examiner's position is respectfully traversed.

Minten actually teaches away from employing a graphite-containing dispersion to form conductive coating in the through holes of a circuit board. At col. 20, lines 20-65, Minten teaches that when graphite was substituted for carbon black in the dispersion used to make the conductive coating, and the through holes were subsequently electroplated, the copper layer failed to adhere to the graphite conductive layer (i.e. copper pull-away) in one example, and resulted in voids in almost all of the holes in the second example. Further, the lack of adhesion was attributed to the thickness of the graphite layer, which was stated to be visible. Minten concluded that the graphite dispersions were "far inferior" for copper electroplating purposes compared to the carbon black dispersions. Thus, contrary to the Examiner's position one skilled in the art would not be motivated to modify Minten's circuit boards by substituting a graphite coating to achieve the present invention, because Minten himself teaches that making such a substitution does not result in a conductive graphite coating that accepts electroplating to provide a surface at least substantially free of visible voids, as required by claims 19 and 20.

Further, claim 20 requires that the conductive graphite coating be not greater than 12 microns thick. As set forth in the Specification, at paragraph 101, coatings should be thin enough that they cannot be seen even under a 200 power microscope. With thicker coatings, pullaway (i.e. delamination of the copper layer) becomes more probable. Minten however, does not teach

or suggest a graphite coating that is not thicker than 12 microns, as required by claim 20. Indeed, Minten teaches that with the graphite coating he employed, "a visible layer of dried graphite dispersion was observed." *See*, col. 20, lines 53-57, *emphasis added*. Since Minten's graphite layer was visible, it was clearly thicker than the maximum 12 micron thickness required by claim 20. Moreover, Minten provides no teaching or suggestion of how to achieve a graphite coating that is not thicker than 12 microns. Accordingly, Applicants submit that dependent claim 19 and independent claim 20 are not obvious in view of Minten for the additional reason that Minten provides no teaching or suggestion of how to achieve a graphite coating suitable for electroplating through holes and, indeed, teaches away from using such a coating.

Finally, with respect to dependent claims 3-11, claiming various resistivities, Applicants wish to point out that, contrary to the Examiner's belief that no advantages to such resistivities are recited, the Specification states that lower resistivities enable faster electroplating speeds. (See paragraph 90). As can be easily appreciated, faster plating speeds lead to faster and increased product output, which is clearly an advantage over the prior art systems. Thus, lower resistivities enable improved conductivity which leads to improved production rates on the printed wiring board production line. Further, as discussed above, Applicants' '807 patent describes the disadvantages of a coating exhibiting high electrical resistance.

As explained in paragraph 95 of the Specification, and as exemplified in the '807 patent, the commercially available BLACKHOLE carbon black process, which is essentially the same process taught by the Minten patent, results in resistivities more than 10 times as great, and sometimes more than 50 to 70 times as great as those of the preferred graphite coating of the present invention. Thus, although lower resistivities, such as those recited in dependent claims 3-

11, are desirable, the Minten patent does not teach or suggest how such low resistivities can be achieved with his carbon black dispersion.

In summary, claims 2-22 are not obvious in view of the Minten patent because Minten does not teach or suggest a conductive coating that includes a water-dispersible organic binder, as recited in claims 2 and 20. In addition, dependent claim 19 and independent claim 20 are not obvious in view of Minten for the additional reason that Minten does not teach or suggest a graphite coating that accepts electroplating to provide a surface at least substantially free of visible voids, as required by those claims.

For all the above reasons, it is submitted that the claims are patentable over the art of record, and reconsideration of the Examiner's rejection is respectfully requested.

AUTHORIZATION TO CHARGE ADDITIONAL FEES

* The Commissioner is hereby authorized to charge any fees which may be required by this paper and during the pendency of this application to Account No. 13-0017.

Respectfully submitted,

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DATE

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